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A Research Note

USE OF SODIUM ASCORBATE OR ERYTHORBATE TO INHIBIT FORMATION OF N-NITROSODIMETHYLAMINE IN FRANKFURTERS

INTRODUCTION

RECENTLY our Laboratory confirmed the presence of 11 to 84 ppb of dimethylnitrosamine (DMNA) in 3 of 40 commercial samples of frankfurters (Wasserman et al., 1972). While DMNA has been shown to produce malignant tumors in animals (Magee and Barnes, 1956; Druckrey et al., 1967), the carcinogenic effect in man of DMNA and nitrosamines in general has not been demonstrated, but is a matter of concern. Since more than 16 billion frankfurters were consumed in the United States last year, the presence of even a few samples containing nitrosamines required an investigation into the cause of their formation.

In a study of frankfurters using varying concentrations of sodium nitrite ($NaNO_2$) alone, we found that the legally permissible level of approximately 150 ppm failed to give measurable amounts of DMNA. Under our pilot plant conditions, it appeared that using approximately 10 times this amount of nitrite in the preparation of frankfurters would yield a final product containing at least 10 ppb DMNA (Fiddler et al., 1972). This paper reports the effect of other cure ingredients—sodium nitrate ($NaNO_3$), sodium ascorbate (NaAsc), and sodium erythorbate (NaEry)—on the formation of DMNA in frankfurters.

EXPERIMENTAL

FRANKFURTERS were prepared in the same manner as described previously (Fiddler et al., 1972) using a conventional 2-hr smoking and cooking schedule to bring the frankfurters to an internal temperature of 71°C. An additional 2-hr smoking and heating treatment was used to maintain the frankfurters at 71°C to assess the effect of an extreme condition on DMNA formation. Sodium nitrate, NaAsc or NaEry were added, in separate experiments, to frankfurter emulsions containing $NaNO_2$ at approximately the maximum permissible concentrations (Code of Federal Regulations, 1971) for each ingredient, and at 10 times these amounts. The methodology for the isolation, determination and confirmation of DMNA has been described by Fiddler et al. (1972). Depending on the level of interfering or background components, approximately 10 ppb DMNA or greater were confirmed using a gas-liquid chromatography-low resolution mass spectrometry system. Where DMNA could not be confirmed by mass spectrometry, values are given as the apparent amount of DMNA present as indicated by its GLC retention time alone.

RESULTS & DISCUSSION

RESULTS of the analyses of frankfurters prepared with 150 ppm $NaNO_2$ alone and with $NaNO_3$, NaAsc or NaEry at either the legally permissible level or 10 times these amounts indicated no DMNA to be present with either a 2- or 4-hr processing time. Representative data from analyses of frankfurters prepared with 1500 ppm $NaNO_2$ from several experiments are shown in Table 1. Frankfurters prepared according to the normal 2-hr processing schedule with 1500 ppm $NaNO_2$ alone or in combination with $NaNO_3$ contained approximately the same amount of DMNA: 10 ppb. The results of the 4-hr processing indicate that in general nitrate appears to have little or no effect on DMNA formation.

Sodium ascorbate, or its isomer erythorbate, is used in cure mixtures to speed cure color formation. These compounds act by reducing NO_2^- to nitric oxide which reacts with the meat pigment myoglobin and forms the stable pink nitric oxide hemochrome upon heating. The amount allowable in comminuted meat products is 7/8 oz per 100 lb or 547 ppm with respect to the meat (Code of Federal Regulations, 1971). Frankfurters prepared with either 550 or 5500 ppm NaAsc or NaEry and processed for 2 hr had no DMNA present, in comparison with the approximately 10 ppb present in the samples made with NO_2^- alone. In the case of the frankfurters cooked and smoked an additional 2 hr where a larger amount of DMNA was produced with 1500 ppm $NaNO_2$ alone, addition of Asc^- or Ery^- significantly reduced the amount of nitrosamine formed. Under the conditions used in these studies both reductants behaved similarly and exhibited the same inhibitory activity. While the mechanism for the blocking of the nitrosation reaction is not completely understood, it appears that these reductants compete for the NO_2^- thereby making it less available for the nitrosation of the secondary amine. Ascorbate and Ery^- are also known to reduce the amount of residual NO_2^- in the finished cured product.

The results of the use of the two reductants, NaAsc and NaEry on the inhibition of DMNA formation in frankfurters are similar to those obtained in our model system work (Fiddler et al., 1973).

It appears that the use of a reductant like Asc^- or Ery^- in concentrations greater than that now permitted offers a potential for the preparation of nitrosamine-free cured meat products.

Further research in this area is necessary.

Table 1—Formation of dimethylnitrosamine (DMNA) in frankfurters prepared with 1500 ppm $NaNO_2$ and with $NaNO_3$ or reductants

Cure ingredient	Amount added (ppm)	DMNA, ppb[a] Processing time 2 hr	4 hr
None		11	22[b]
$NaNO_3$	1,700	10	15[b]
$NaNO_3$	17,000	10	32[b]
None		11	22
NaAsc	550	0	7
NaAsc	5,500	0	4
None		10	11[b]
NaEry	550	0	6
NaEry	5,500	0	0

[a] Corrected using the recovery of an aliquot of the same sample with 20 ppb DMNA added
[b] Confirmed by mass spectrometry

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